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ABSTRACT

Designed to provide teachers with low cost laboratory exercises, project ideas, and classroom activities for individuals and groups, this document focuses on the concepts of heredity and embryology. The materials address the topics of: (1) cell division; (2) the identification of the human embryo; (3) chromosomes; (4) DNA; (5) differences in the gestation periods of mammals; (6) the incubation of chicken eggs; and (7) human fetal growth. The materials include ideas for learning stations, quizzes, self-checks, and answer keys. It is intended that the activities will require a minimum of equipment and teacher preparation time. Reproducible handout sheets are also provided. (TW)

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A Good Apple Science Activity Book for Grades 5-8 +

SUPERIFIC SCIENCE

ED 279 502

BOOK II

Learning About Heredity and Embryology

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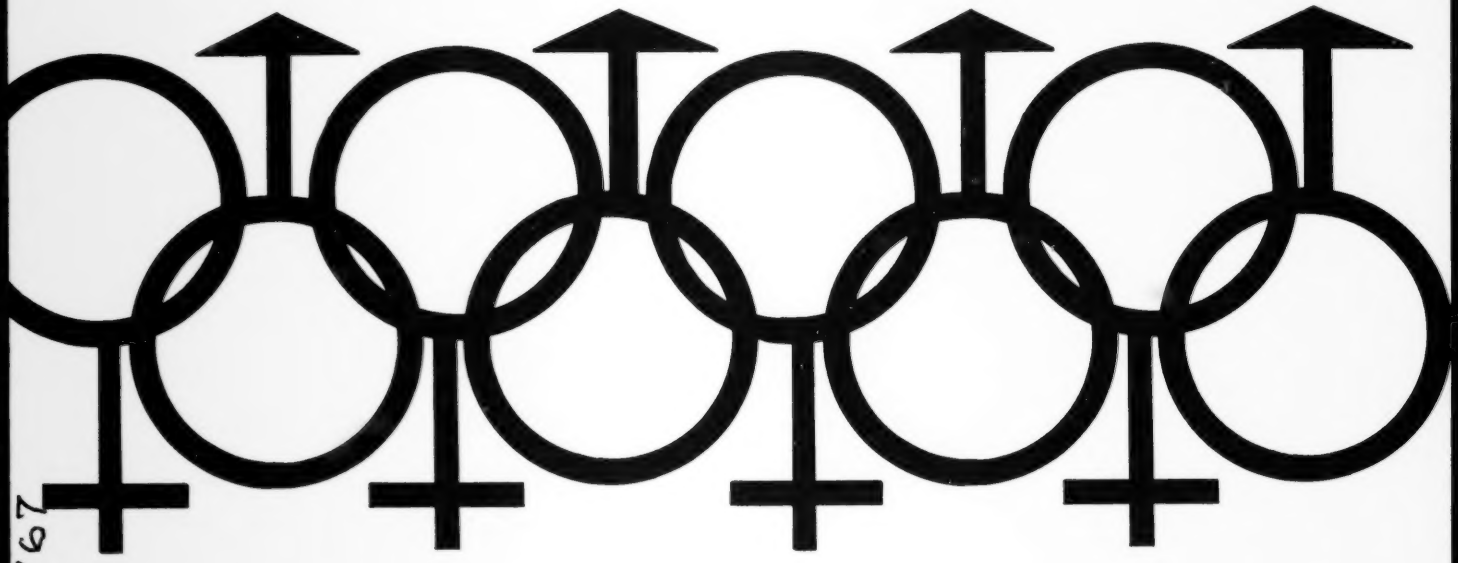

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Written by Lorraine Conway

Illustrated by Linda Akins

SUPERIFIC SCIENCE

HEREDITY AND EMBRYOLOGY

by

LORRAINE CONWAY

illustrated by Linda Akins

Cover illustrated by Nancee Volpe

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TO THE TEACHER

PURPOSE: The Superific Science Book of Heredity and Embryology has been designed to provide low cost, imaginative laboratory exercises, individual and group activities, projects, stations and packets with a minimum amount of equipment and teacher preparation time. The included material may be used as a supplement to other materials or by itself; in either case, interest will be aroused while learning, and some of the remote aspects of science will be brought into the everyday realm of the student.

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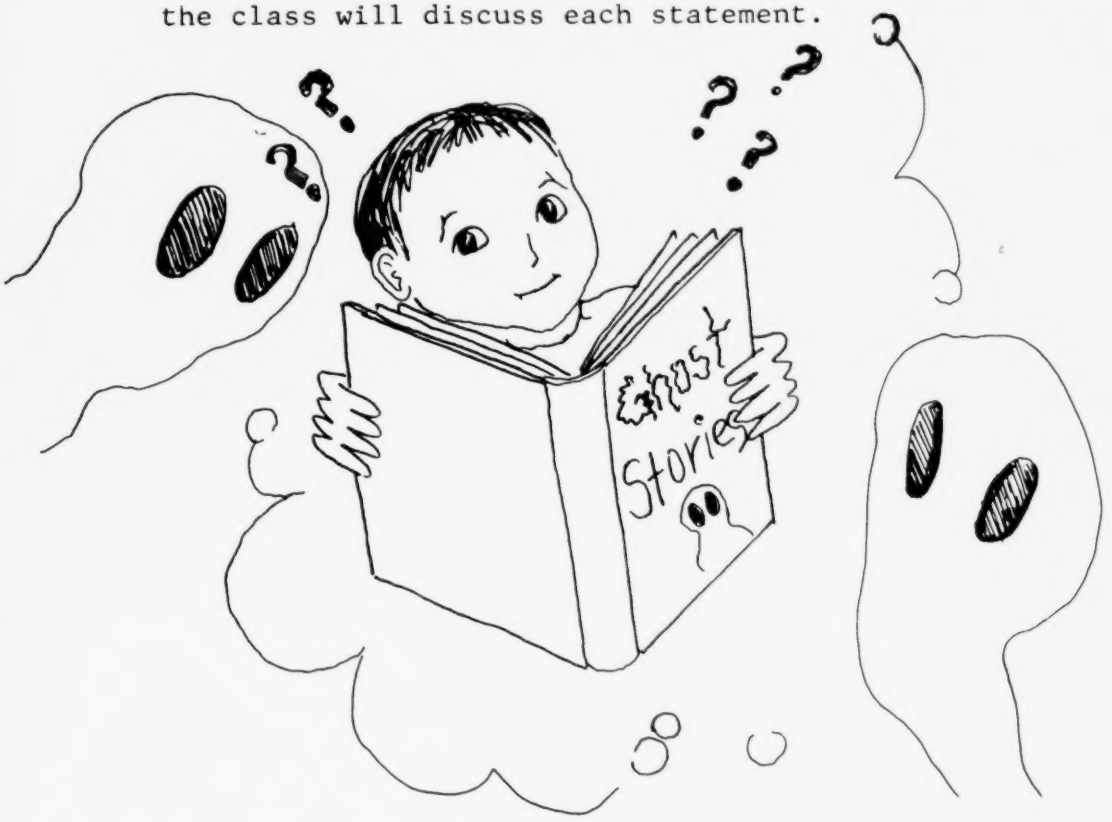
FACT OR FICTION

PURPOSE: There are so many misconceptions concerning heredity that a simple fact or fiction sheet becomes a valuable tool for getting started on the subject of genetics. The same set of questions may be given again at the conclusion of the study of genetics to ascertain which, if any, misconceptions have been clarified.

MATERIALS: Set of questions which can be reproduced on a ditto sheet or simply be read to the class by the teacher.

PROCEDURE: The teacher reads the questions to the class or passes out copies of the questions. The students indicate by a checkmark whether they believe the statements are fact or fiction. After all finish, the class will discuss each statement.



FACT OR FICTION

FACT	FICTION

1. Man is the highest of the animals; therefore, he has the most chromosomes.
2. An injury suffered in an accident will be passed on to one's children.
3. If your parents both have brown eyes, you will certainly have brown eyes.
4. You have inherited traits which are not apparent.
5. Hereditary traits are carried from parent to child through the blood.
6. Each person inherits exactly half of his genetic makeup from each parent.
7. You inherit more from your mother if you are a girl.
8. A parent may give a trait to his child without ever having the trait himself.
9. If you resemble one parent more than the other, you probably inherited more from that parent.
10. You have all the hereditary traits you are ever going to have at birth.

CELL DIVISION

PURPOSE: To determine whether by the use of logic and observation a student can correctly put the stages of mitosis in the order of their correct sequence.

MATERIALS: A ditto sheet with the cell division drawings in a scrambled order and scissors.

PROCEDURE: Cut out the drawings on the following page and try to put them in order. The drawings are of normal body cells in the process of dividing into two cells. Then answer the following questions:

The drawings on the next page are not in order; cut them out and put them in the correct order to illustrate cell division.

1. The interphase is the stage between cell division; which drawing is the first, or interphase? _____

2. The first sign of cell division is the prophase: which drawing is the prophase? _____

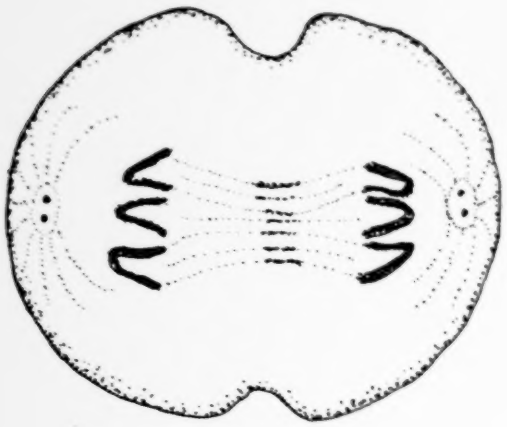
3. The prophase is followed by the metaphase; which drawing represents the metaphase? _____

4. In the anaphase the chromosomes have gone to the opposite poles of the cell. Label the appropriate drawing anaphase. _____

5. In the telophase the two daughter cells begin to form; label the appropriate drawing telophase. _____

6. The two new cells have been formed. Label this drawing daughter cells. _____

a. _____



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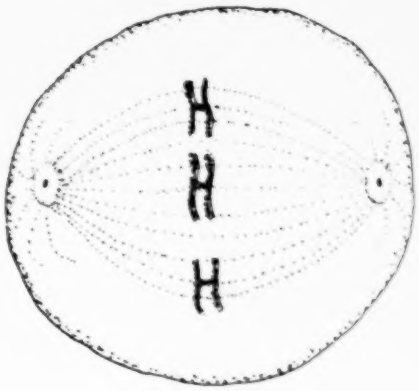
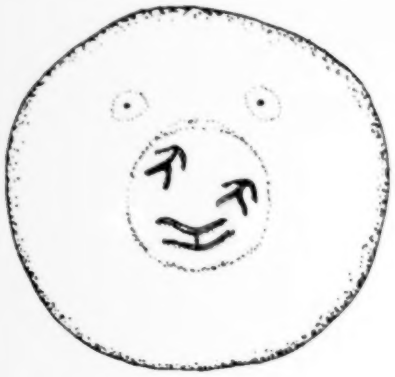


c. _____



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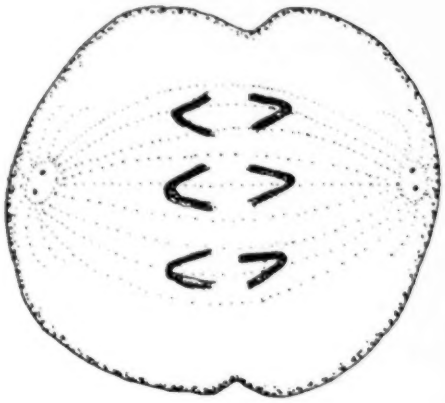
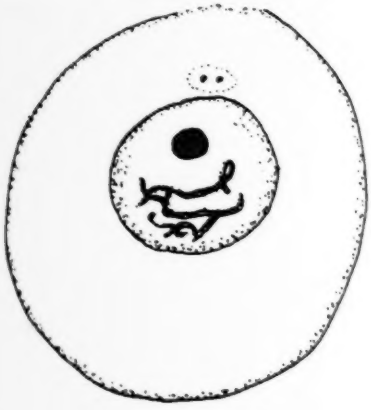
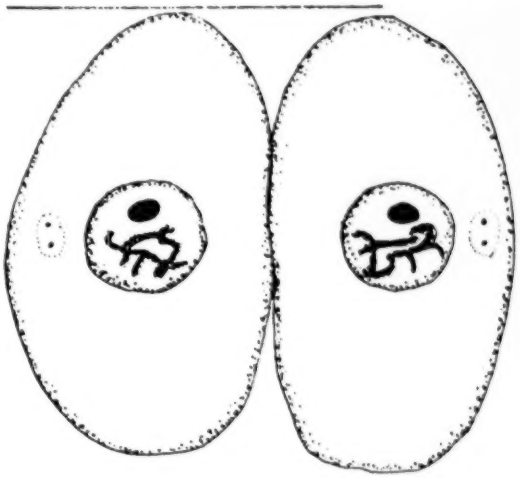


e. _____



f. _____

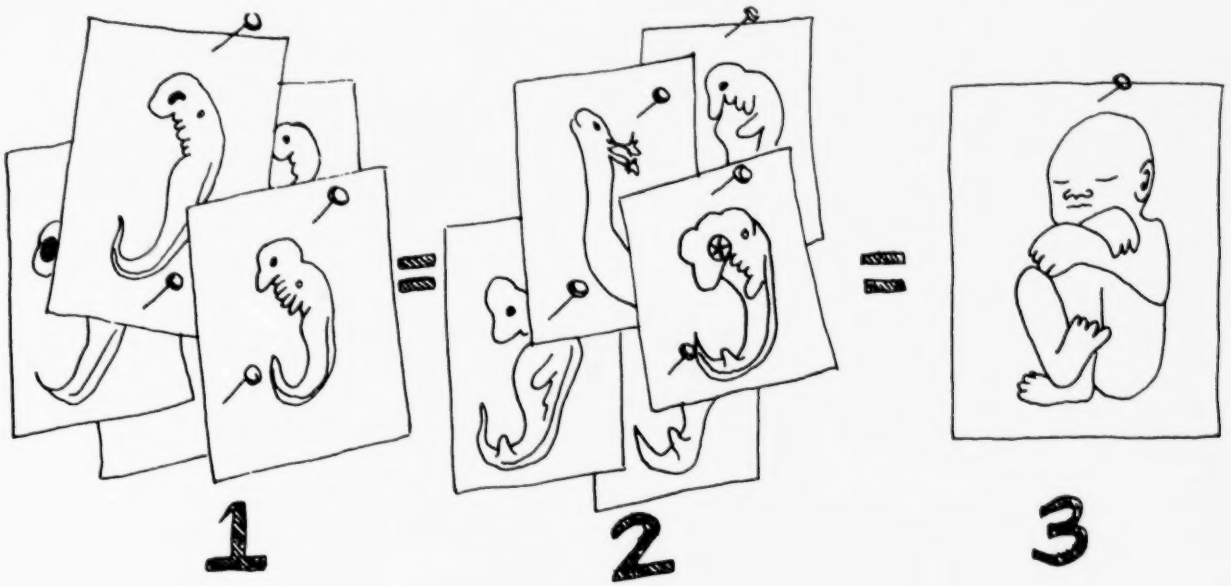


CAN YOU IDENTIFY A HUMAN EMBRYO?

PURPOSE: To show that during the embryonic development of vertebrates a great similarity exists which can only be distinguishable to an expert, to stimulate interest in embryology, and to show some basic embryonic features.

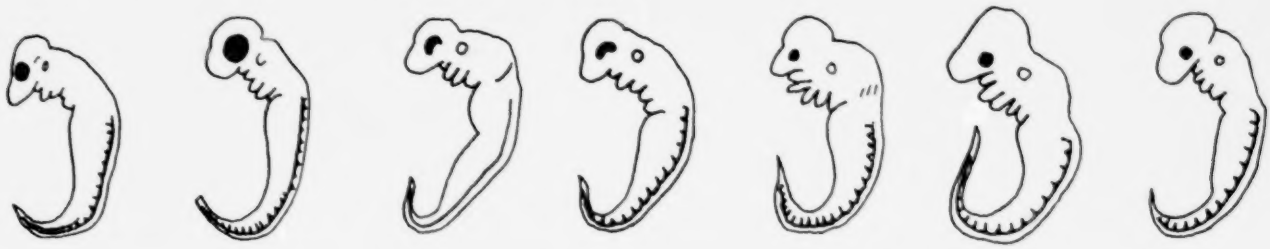
MATERIALS: This lab can be done effectively by the use of a sheet of drawings, or the drawings may be reproduced on 3" x 5" cards.

PROCEDURE: Reproduce the embryos and fetuses as shown in the sample sheet. Fold paper on the fold lines so that the top row alone is visible, the middle row unfolds secondly, and the bottom row last. The students, seeing only the top row of embryos, try to determine which embryo is human, fish, rabbit, chicken, turtle, salamander, and pig. After this is done the middle row is unfolded; with this additional information, the students make a second determination. Finally, the bottom row is unfolded; at this point most students can correctly identify the embryos.



EMBRYOS OF VERTEBRATES

DIRECTIONS: Do not unfold. First, try to determine which embryo is that of a human, a fish, a rabbit, a chicken, a turtle, a salamander, and a pig. After you have done this, go to row 2; then, row 3.



a_____ b_____ c_____ d_____ e_____ f_____ g_____

Fold_ _ _ _

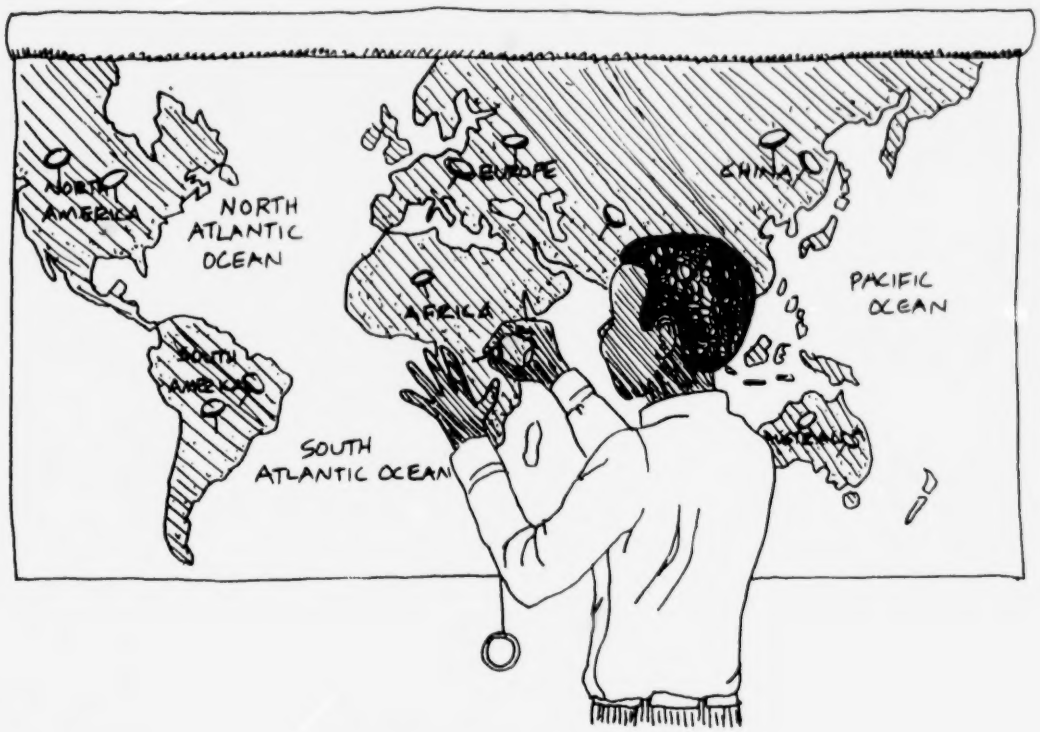
TRACE YOUR ANCESTRY

BULLETIN BOARD

PURPOSE: To have students identify with their past, to show them their uniqueness and their commonalities.

MATERIALS: Map of the world mounted on a bulletin board or other similar backing, two packages of colored pins (two different colors).

PROCEDURE: After the world map has been mounted, each student will indicate his primary ancestry by placing colored pins in the countries of his ancestors. Two pins per student should be sufficient; one for maternal ancestors and one for paternal ancestors; however, some students may have ancestry from more than two countries and may wish to indicate this.



BOY OR GIRL?

PURPOSE: To teach the fact that two X chromosomes determine the female sex and an X and a Y chromosome determine the male sex. This lab shows that the female parent can only contribute X chromosomes to her offspring while a male parent can contribute either an X or a Y, thereby determining the sex of the offspring.

MATERIALS: Two containers such as paper sacks or boxes, twenty buttons alike except for color: fifteen should be pink, and five should be blue. (Other objects such as pieces of colored paper cut round or square, toothpicks, chips from games, etc., can be used.)

PROCEDURE: Into one sack put ten pink buttons; into the second sack put the remaining five pink plus all of the blue buttons. This can be done for each pair of students or by having two students demonstrate at the front of the classroom. One student (female parent) will hold the sack with the ten pink buttons, the other student (male parent) will hold the sack with the five pink and five blue buttons. Without looking into the sack, each parent will take out a button; the pink button represents an X chromosome, the blue a Y chromosome. If the combination turns out to be two pink buttons (XX), the child will be a girl; a blue and a pink button combination (XY) represents a boy.

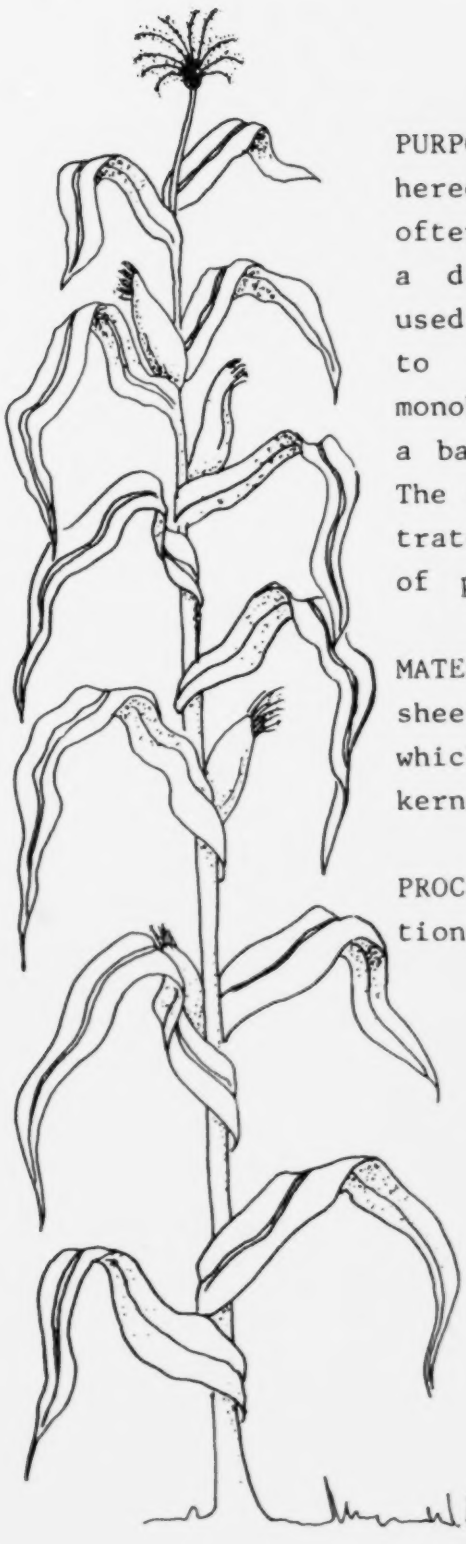
Return buttons to original sack and shake after each turn. Record data on chart below as shown in the example. Complete suggestions and questions at the bottom of this page.

A chart similar to this can be given to each student before the experiment begins. Each student should complete the chart as the experiment takes place.

	X Chromosome		Y Chromosome		Sex of offspring
1.	✓	✓			Female
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

1. For the best results repeat this activity several times. Students can complete a chart each time.
2. Add the numbers to get the totals for boys and girls. How many of each result from the experiment?
3. What is the ratio of boys to girls?
   Number of girls _____ Number of boys _____
4. Is this about the same ratio that occurs in real life? _____

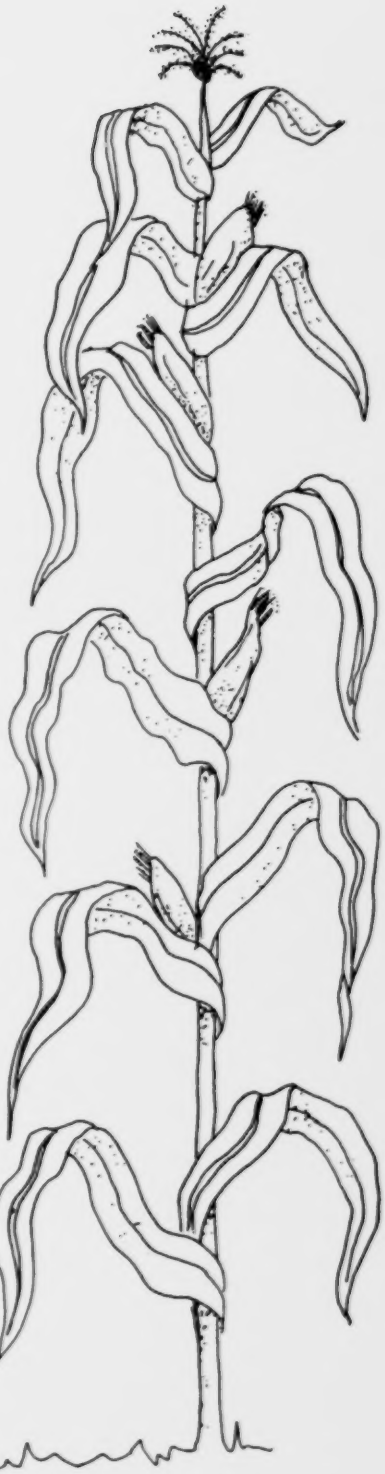
GENETIC CORN



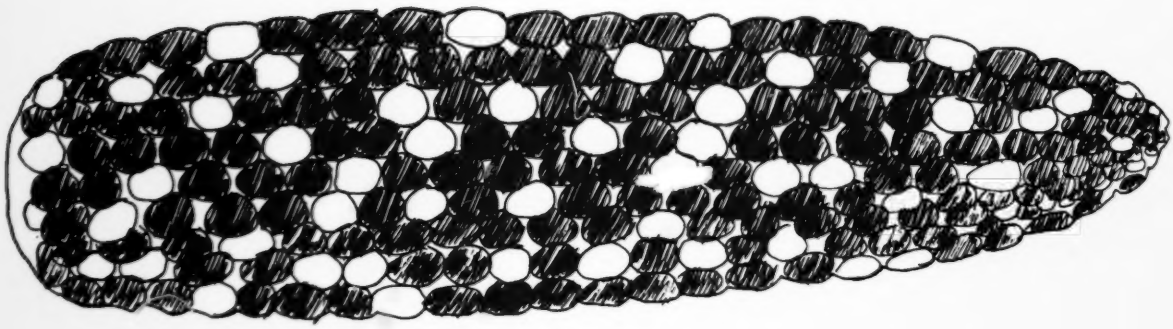
PURPOSE: In the study of heredity genetic corn is often used. In this exercise a drawing of the corn is used instead of real corn to illustrate the simple monohybrid cross which is a basic concept of heredity. The idea can be easily illustrated without the cost of purchasing genetic corn.

MATERIALS: Drawing or ditto sheet of genetic corn in which the ratio of dark kernels to light is 3 to 1.

PROCEDURE: Answer the questions on the following page.



GENETIC CORN



Answer the questions below. Use diagrams at the bottom of the page for checking answers.

1. Estimate the ratio of dark kernels to light kernels in the ear of corn pictured above.

   a. 1 dark to 3 light b. 2 dark to 2 light

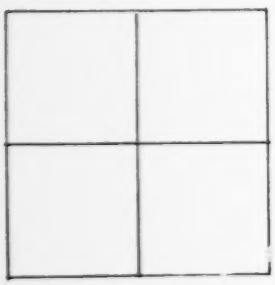
   c. 3 dark to 1 light

   Assume that dark (R) is dominate to light (r), and this ear of corn is the F_2 generation. The parents (F_1) of this ear of corn were all dark.

2. What is the genetic makeup of the parents (F_1) of this ear of corn?

   a. RR X rr, b. Rr X Rr, c. RR X rr, d. RR X RR

3. What is the genetic makeup of the grandparents (P_1) of this ear of corn?

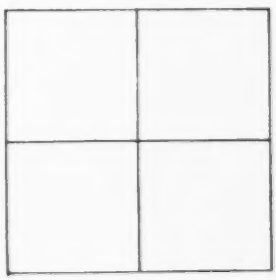


a. RR X rr

b. Rr X Rr

c. rr X rr

d. RR X RR



DIFFERENCES IN THE GESTATION PERIOD OF MAMMALS

PURPOSE: The gestation period is the time between fertilization and birth. In mammals this takes place in the uterus of the female parent. Although the time varies widely with various species, it can be shown instantly by means of a graph.

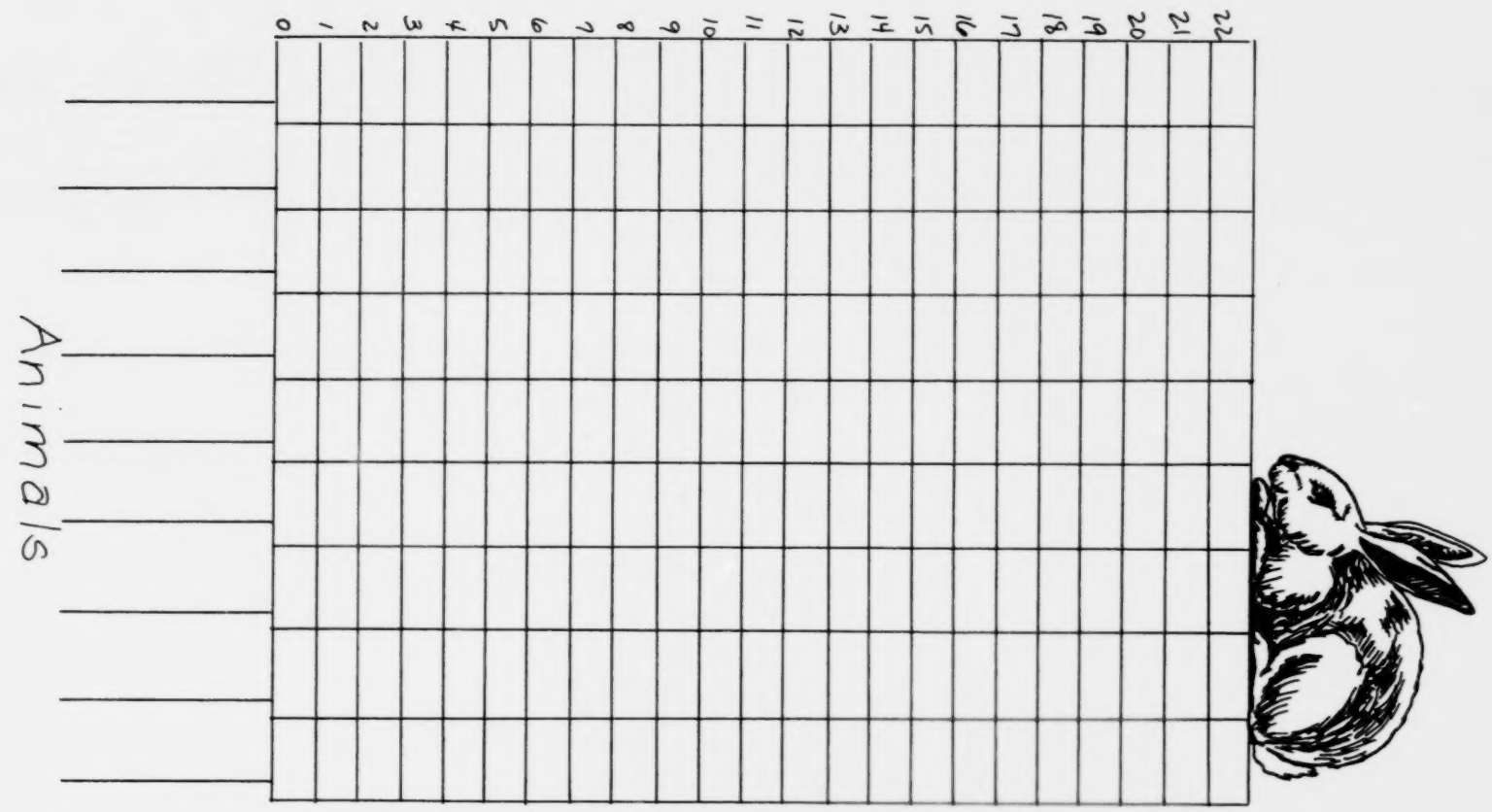
MATERIALS: Gestation information and graph paper.

PROCEDURE: Plot the gestation periods of the following animals on a bar graph.

ANIMAL	GESTATION PERIOD
rabbit	1 month
horse	11 months
mule deer	7 months
domestic cat	2 months
elephant	22 months
human	9 months
pig	4 months
cow	10 months
domestic dog	2 months

On the following page is a sample bar graph worksheet that could be used for this activity. You may wish to use it or you may create your own. Another alternative is to allow each student to design his own graph.

Gestation Period of Mammals in Months



TRANSFUSION STOPLIGHTS

PURPOSE: To give practice in better understanding of the donor-receiver relationships in blood typing.

MATERIALS: Stoplight sheet showing all blood type conditions.

PROCEDURE: Show on the stoplight whether the blood donor indicated at the top of the stoplight can safely give blood to receivers which are indicated at the side of the lights. Do this by coloring the light red if the blood cannot be safely transfused, green if it can.

In humans there are four designated blood types: A, B, AB, and O. These types are determined by the presence or absence of agglutinogens. Type A blood has agglutinogen A present; type B blood has agglutinogen B present; type AB blood has both A and B agglutinogens present; and type O blood has neither A nor B agglutinogens. The clumping of red blood corpuscles will result if a foreign agglutinogen is introduced.

Type A can donate blood to another A or an AB (AB already having agglutinogen A present).

Type B can donate blood to another B or an AB.

Type AB can donate only to another AB (will clump A, B, or O).

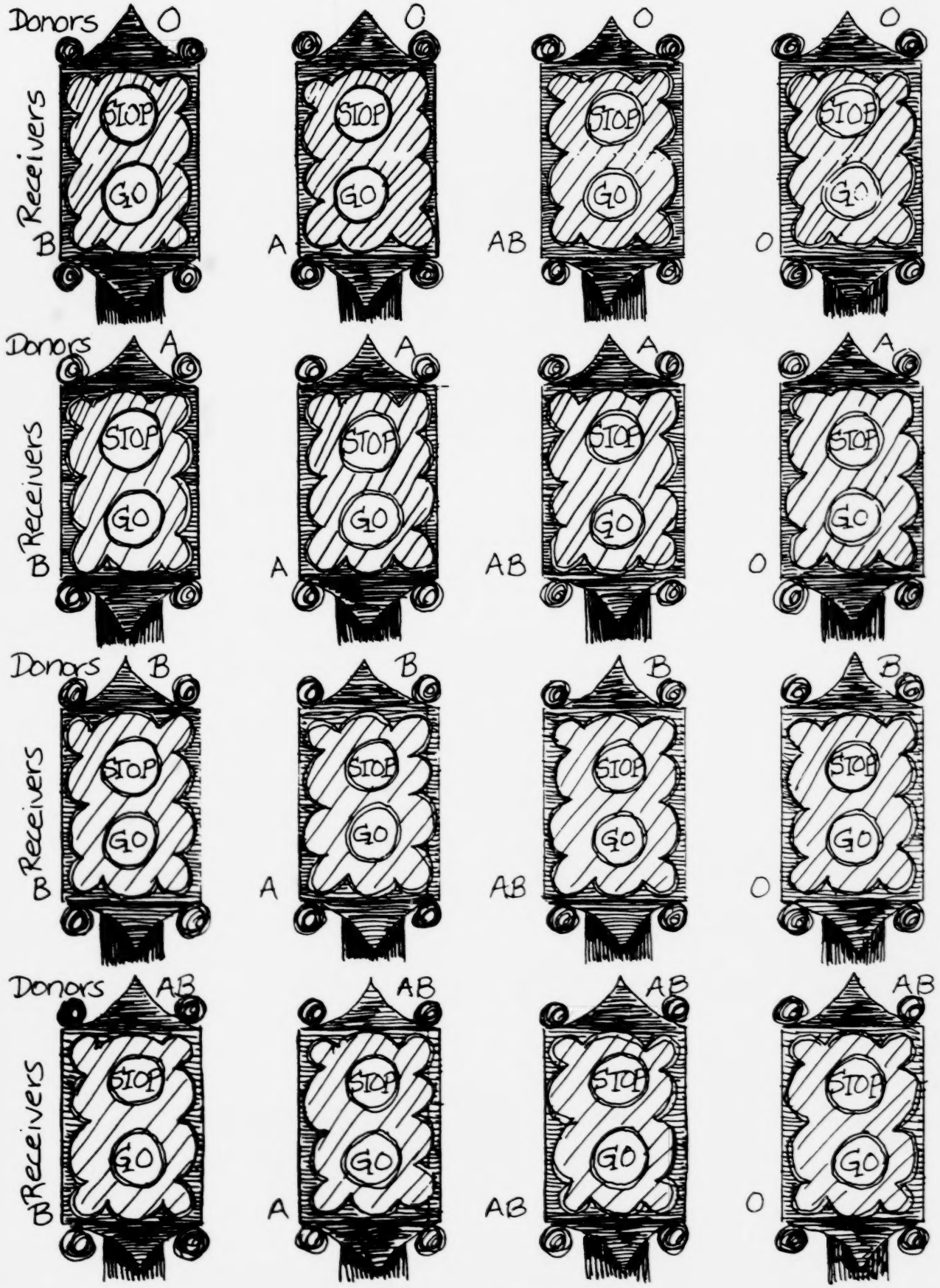
Type O can donate to A, AB, B or O. (O has no agglutinogens and does not clump any type blood. Type O is the universal donor).

Type A can receive from O or A.

Type B can receive from O or B.

Type AB can receive from AB, A, B, or O (type AB is the universal receiver).

Type O can receive from O.

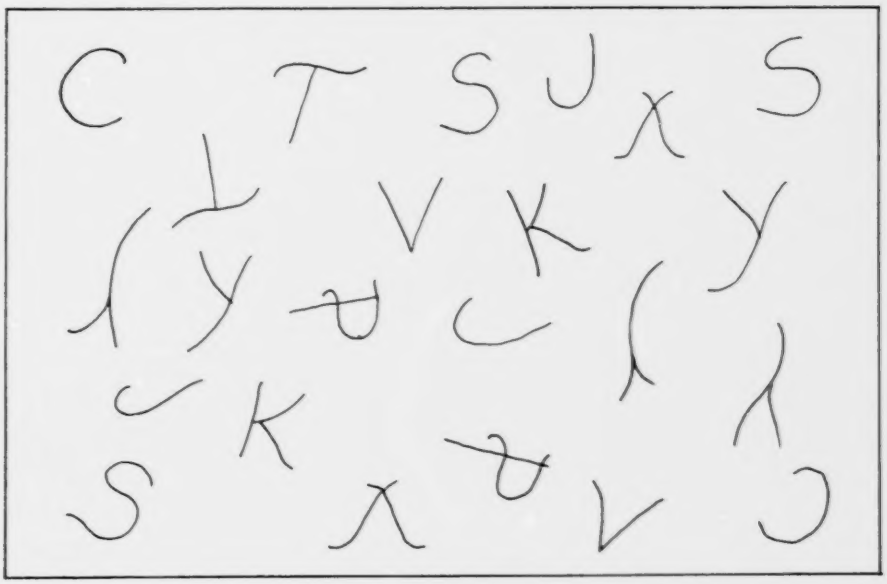

Donors
Receivers
O
B
A
AB
STOP
GO

CHROMOSOME COUNT

PURPOSE: To show the students how chromosomes are matched in chromosome studies by genetic counselors.

MATERIALS: Chromosome worksheet and scissors. Paste or glue is optional.

PROCEDURE: Given below is a set of chromosomes taken from the salivary gland of an imaginary beetle. Normally, this beetle has ten matched pairs of chromosomes. The chromosomes are matched by individually cutting them out and placing them beside their matched partners. Extra chromosomes and missing chromosomes usually constitute an abnormality. By cutting out each chromosome and matching it with its partner as genetic counselors do, determine whether or not this beetle has the normal matched pairs.



BABY MIX UP

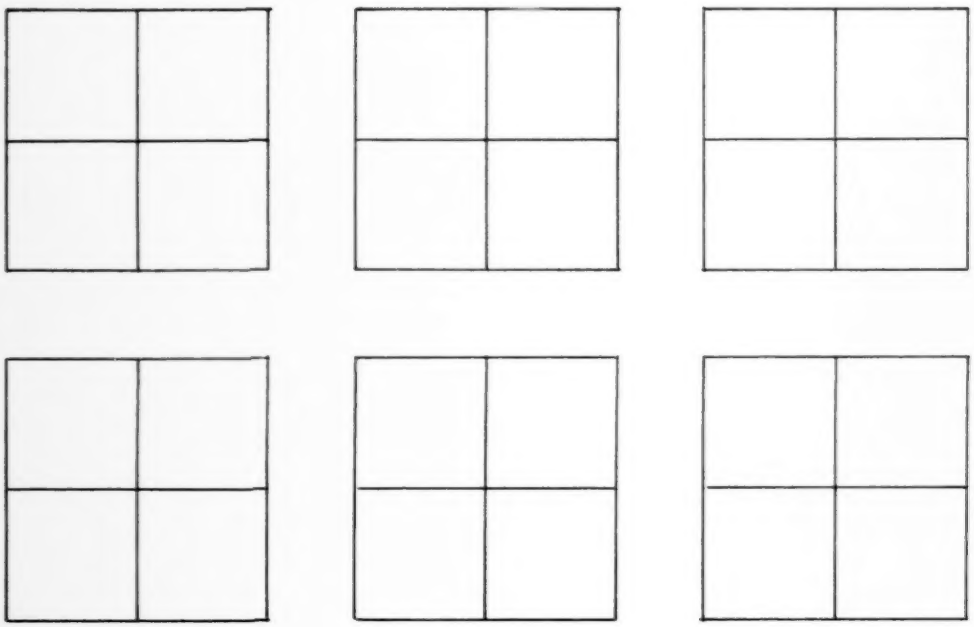
PURPOSE: To give practice in the study of blood types by working backwards from the known types of the offspring to the unknown types of the parents.

MATERIALS: The Baby Mix Up can be duplicated or put on the blackboard.

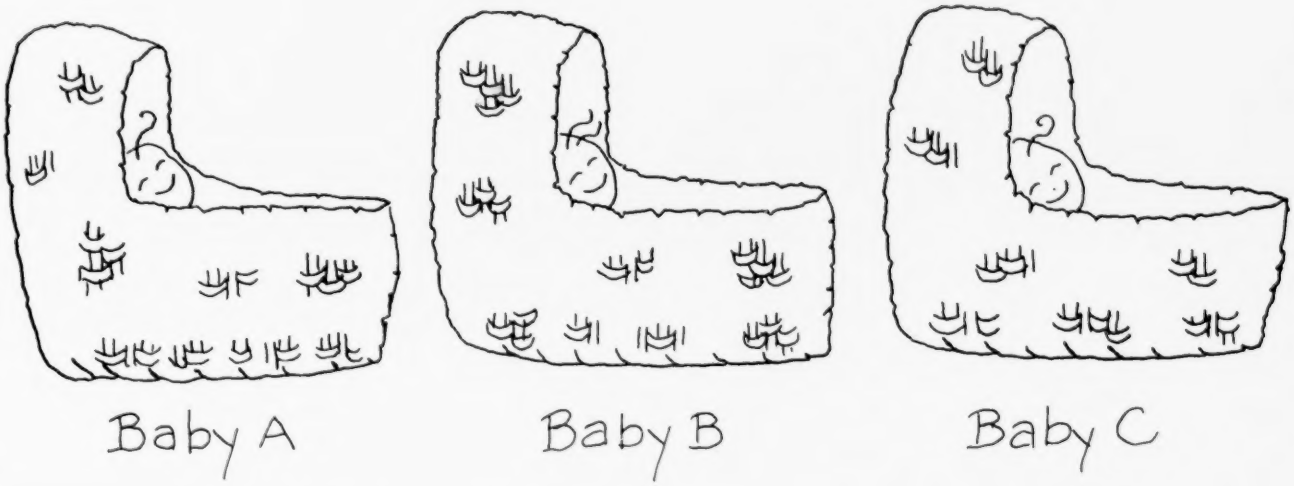
PROCEDURE: Work the problem by means of Punnett squares, using all possible gene combinations. Six Punnett squares are provided, more will be needed.

EXAMPLES:

Type O blood, only OO genes.
Type AB blood, only A and B genes.
Type A blood, genes A or O.
Type B blood, genes B or O.



THE BABY MIX UP



In a hospital three babies were born simultaneously during a thunderstorm. The lights went off for a few seconds, during that time the babies were mixed. The hospital wants to be sure that it is giving the right baby to the right parents by attempting to match the blood types. Can you help?

The four human blood types are A, B, AB, and O.

Type A dominates O, so those having type A have either AA or AO genes.

Type B dominates O, so those with type B have either BB or BO genes.

Type AB, neither gene dominates; one gene is A, one is B.

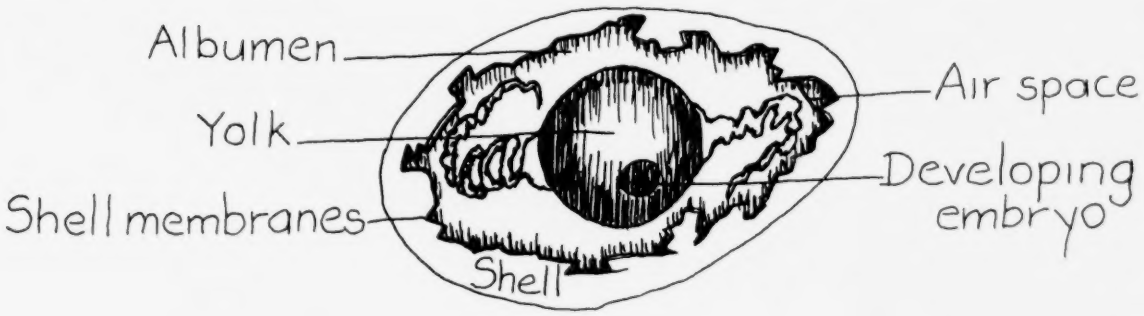
Type O is recessive to A and B, so its genes must be OO.

PARENTS	CHILDREN
The McBrides = type O and AB	Baby A is type AB
The Gonzales = type A and B	Baby B is type O
The Pepronis = type A and O	Baby C is type B

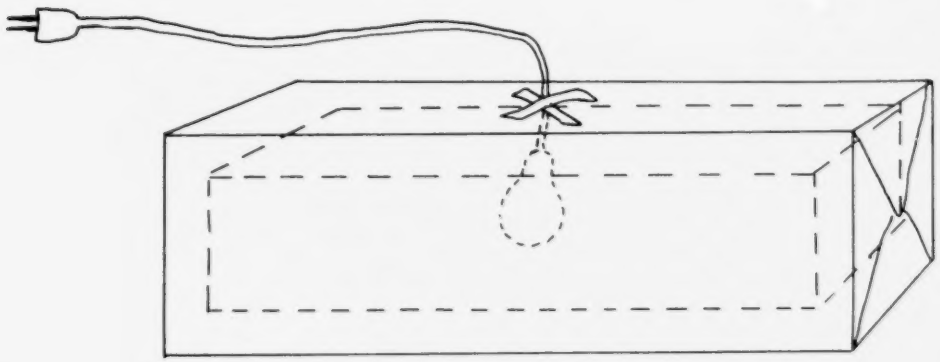
1. Who are the parents of baby A? _____
2. Who are the parents of baby B? _____
3. Who are the parents of baby C? _____

INCUBATION OF CHICK EGGS

PURPOSE: To study first hand the embryological development of chicks by the incubation of fertile chicken eggs.

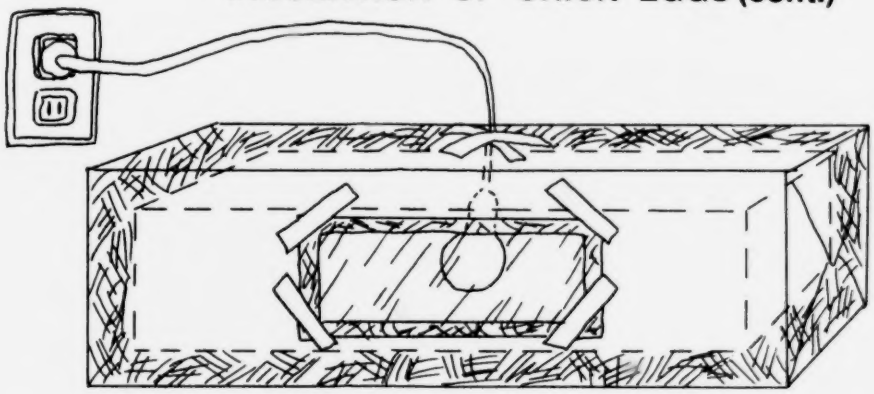


MATERIALS: Two boxes or cartons (one larger than the other so that one fits inside the other, allowing space between the boxes for insulation), insulating material such as fiberglass or styrofoam, one 40-watt light bulb with socket and cord, glass pane, pan of water, electrical tape, and a pencil.



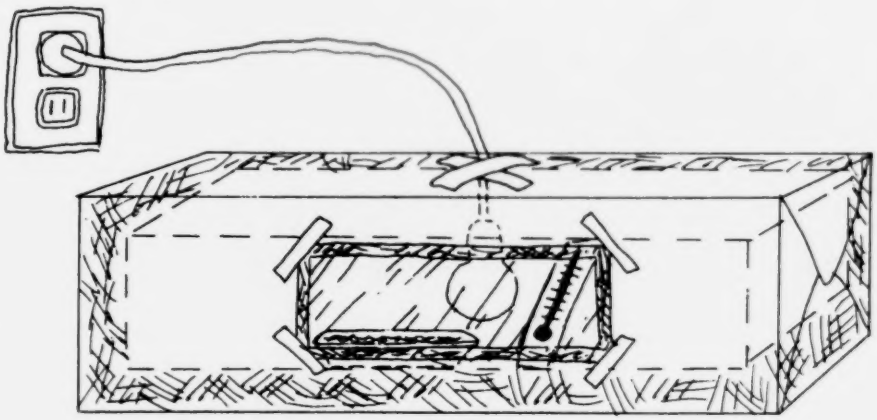
PROCEDURE: With carton turned on side, place smaller carton inside the larger. Cut a hole on top for light socket; screw in bulb from inside, tape around socket to secure.

INCUBATION OF CHICK EGGS (cont.)



Cut a window on the side of the incubator, insert glass, tape in place. Pack insulating material between cartons.

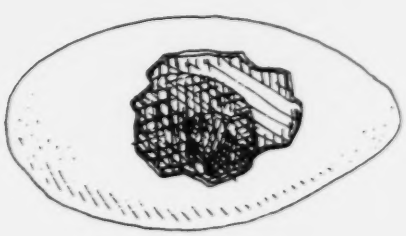
Hang thermometer and place pan of water (to maintain humidity) in box. The temperature should stabilize between 99°F and 101°F. If temperature goes above 101°F, open flaps of box slightly.



INCUBATION OF CHICK EGGS (cont.)

With a pencil mark the top of each egg with an "X." This is to remind you to rotate the eggs every day. When rotating the eggs, move them as gently as possible.

Plan your experiment so that you will have enough eggs to break one open at least every third day. Study the embryos live by carefully cutting a window into the shell with dissecting or cuticle scissors. Preserve the embryos in alcohol or formaldehyde solution.



INCUBATION OF CHICK EGGS

Student Observation Chart

	DESCRIPTION OF CHICK EMBRYO
3 Days	
6 Days	
9 Days	
12 Days	
15 Days	
18 Days	
21 Days	

DIRECTIONS: You are responsible for completing this observation chart. Each time an egg is opened, observe it carefully. Write what you observed in the proper space. A drawing may accompany your written explanation.

DNA

PURPOSE: To show that in the structure of the DNA molecule there are only four bases: adenine, thymine, guanine, and cytosine: but because these bases can occur in any order along the length of the DNA molecule, the possibility of two individuals, other than identical twins, having the same genetic code is astronomical.

MATERIALS: Scissors, red, green, blue, and yellow construction paper and 2" wide masking tape.

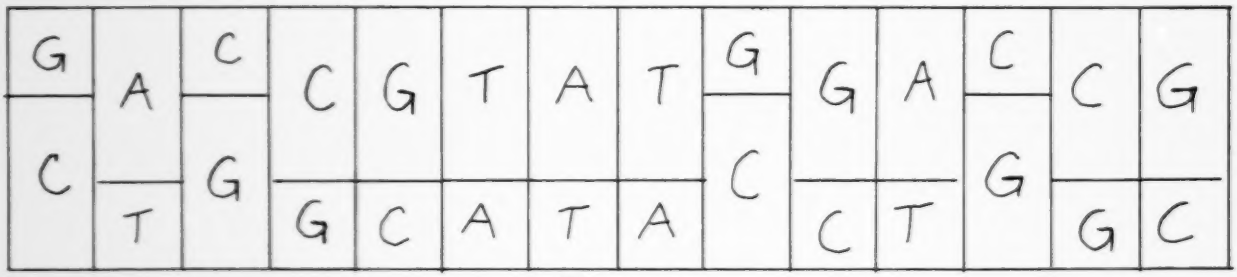
PROCEDURE: To each student or pair of students give one meter of masking tape, scissors and red, green, blue, and yellow construction paper. Have the students cut the construction paper into strips one inch long and a quarter of an inch wide. Use the following code:

Guanine -- Red
Cytosine -- Green
Thymine -- Blue
Adenine -- Yellow

Trim one-fourth inch off the length of the cytosine papers (green), and take one-fourth inch from the length of the thymine (blue). Pair up the bases by sticking them onto the masking tape, but follow this one rule: guanine (red) can only be paired with cytosine (green), and thymine (blue) can only be paired with adenine (yellow). Fill the masking tape as illustrated, leaving one inch on the right without bases (paper strips). When all students have completed this project, attach strips making one long chain.

DNA (cont.)

Although guanine combines only with base cytosine, and base thymine combines only with adenine, there is no order along the length which these bases need to follow, which gives enormous possibilities for different genetic inheritance.



DNA

To color code above chart:

G = red

A = yellow

C = green

T = blue

Ordinary paper and paste can be substituted for masking tape: also, the length of one meter can be shortened to a convenient length. The student's individual strips should be combined into one long strip to increase the effectiveness of this activity.

A CHROMOSOME STUDY

PURPOSE: This exercise shows students that chromosomes usually come in pairs; missing or extra chromosomes do not make superior individuals, rather they cause abnormalities.

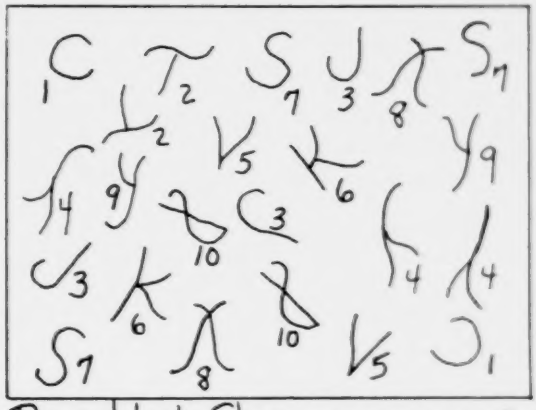
MATERIALS: Ditto sheet on the following page, including the information given and the drawing of a normal beetle.

PROCEDURE: Follow the given directions as they appear on the ditto sheet.

A CHROMOSOME STUDY

DIRECTIONS:

In an imaginary beetle there are ten pairs of chromosomes if this insect is normal. Extra Y_4 chromosomes result in a beetle lacking an antenna; an extra S_7 chromosome causes blindness; extra J_3 chromosomes cause the loss of the first two pair of legs; and lack of a V_5 chromosome causes infertility. Using this information, draw and describe the imaginary beetle with the given set of chromosomes in the box below. A healthy specimen is shown on the left.



Beetle's Chromosomes

Normal Beetle

Beetle with extra or missing chromosomes

BUILD A DNA LADDER

PURPOSE: To help the student better understand the way in which the DNA ladder is constructed.

MATERIALS: Ditto sheet with pattern pieces, scissors.

PROCEDURE: Cut out all the pattern pieces. From these pieces construct a DNA ladder. The pieces can be found on the following two pages. Then, answer the following questions:

1. C is always joined to _____ and _____.
2. T is always joined to _____ and _____.
3. G is always joined to _____ and _____.
4. A is always joined to _____ and _____.

D represents a Sugar. P represents a Phosphate.

In the ladder you construct:

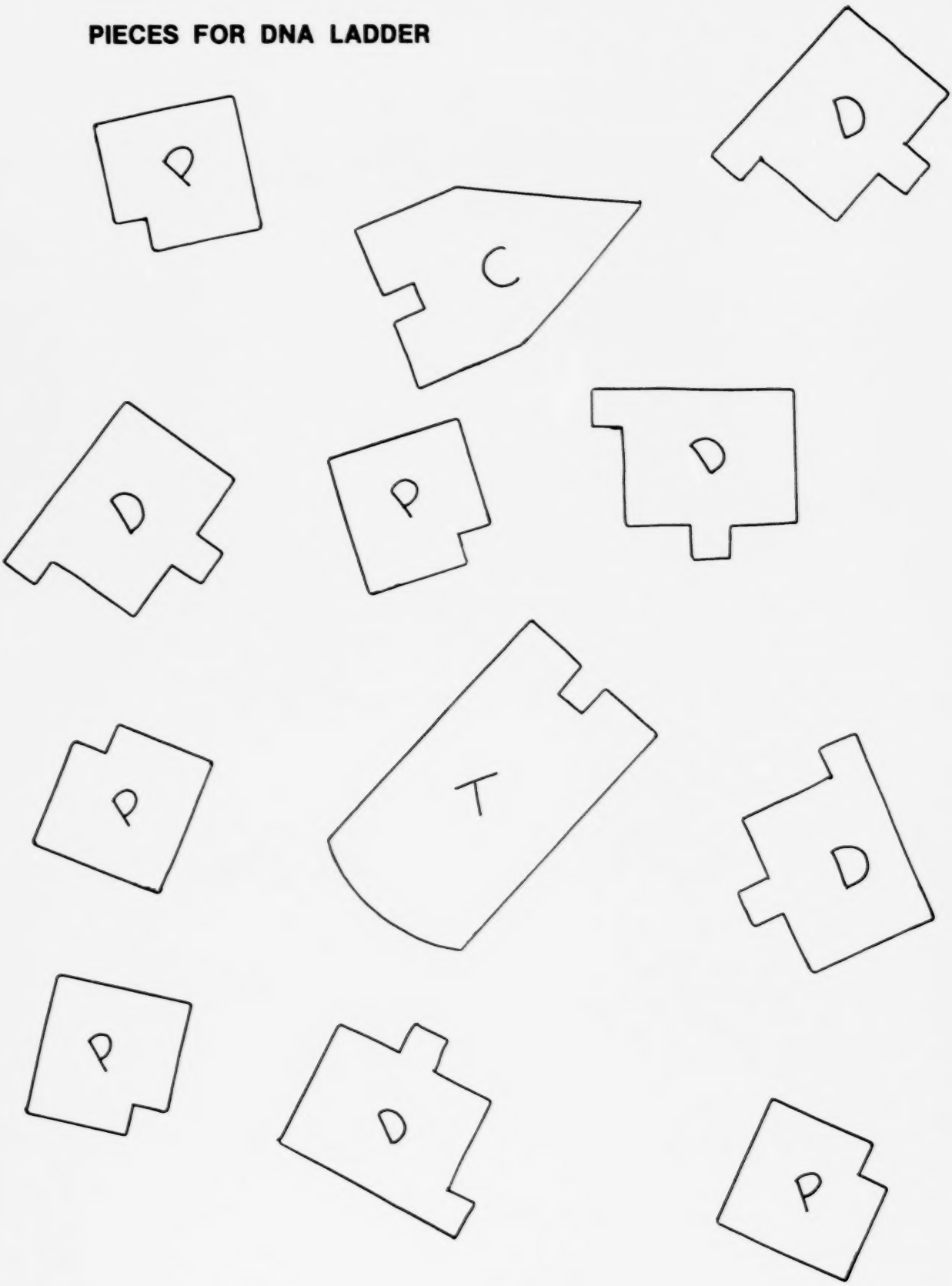
5. Sugars are joined to _____.
6. The rungs of the ladder are represented by which letters? _____
7. Which letters represent the sides of the ladder?

   _____
8. Can you explain what you have constructed? _____

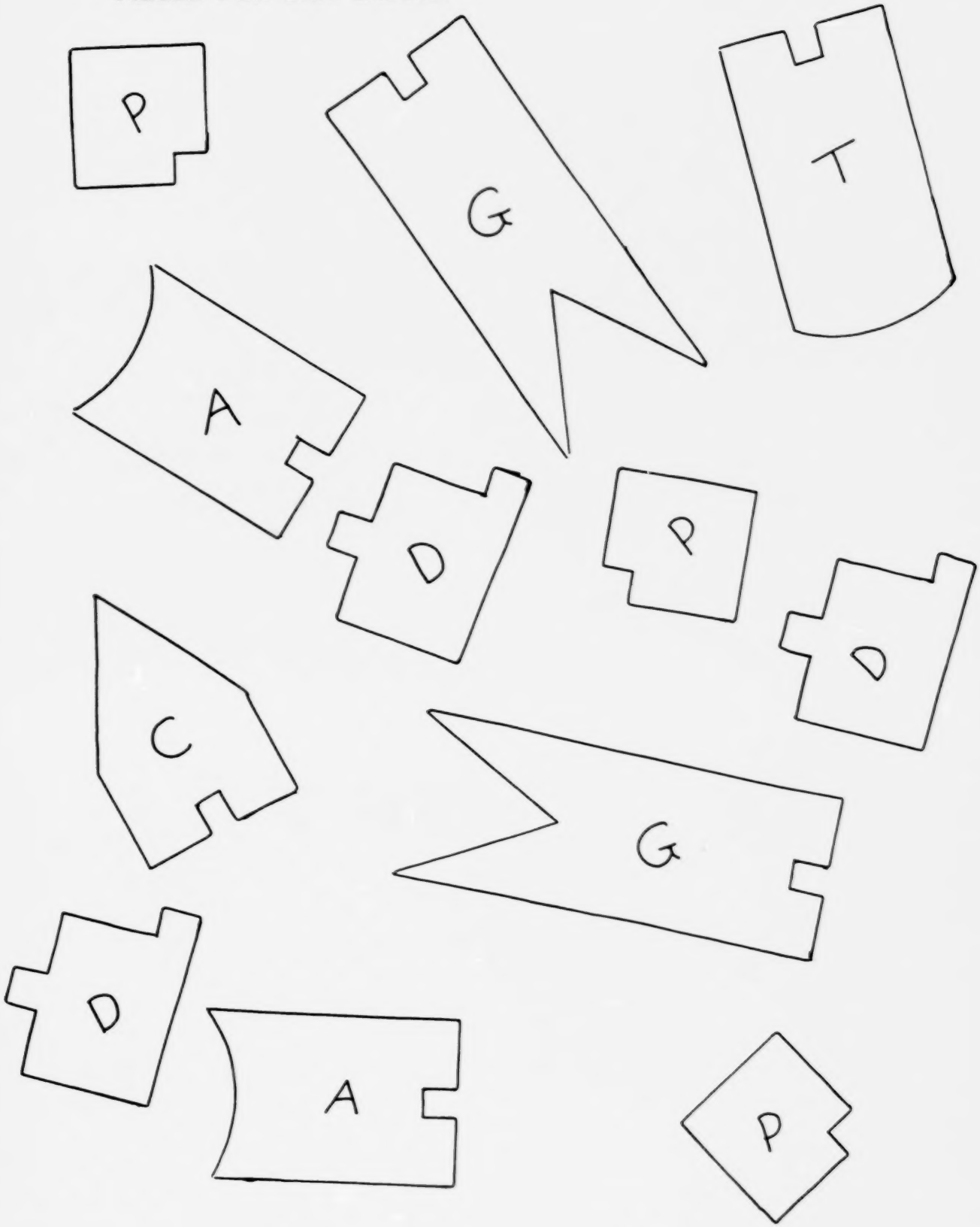
   _____

   _____

PIECES FOR DNA LADDER



PIECES FOR DNA LADDER



GENETIC MAGIC SQUARE

PURPOSE: This is a self-test exercise on heredity in which the student can determine if his answers are correct by simply adding the number answers in any column of blocks. If correct, the sum will be 34.

MATERIALS: A copy of the Genetic Magic Square.

PROCEDURE: In the lettered squares put the correct numbered answer to complete the matching exercise. Every column across or down will add up to 34 if each is answered correctly.

a.	b.	c.	d.
e.	f.	g.	h.
i.	j.	k.	l.
m.	n.	o.	p.

GENETIC MAGIC SQUARE

1. Sperm
2. Identical twins
3. Mutation
4. Gene pool
5. High energy rays
6. Recessive
7. Mendel
8. XY
9. Extra chromosome
10. Incomplete dominance
11. Fraternal twins
12. DNA
13. XX
14. Egg
15. Probability
16. Zygote

DIRECTIONS: Complete the sentences below by matching the above terms to a definition. Put the number of the term in the proper blank.

a. _____ are female chromosomes.

b. _____ develop from a single egg and a single sperm cell.

c. _____ is a change which can be transmitted to future generations.

d. _____ is formed when a sperm cell united with an egg cell.

e. _____ is a substance found in genes.

f. _____ is considered the "Father of the Science of Heredity."

g. _____ is a trait which will not appear unless two genes for it are present.

h. _____ can cause Mongolism.

i. _____ are male chromosomes.

j. _____ develop from two eggs and two sperms.

k. _____ occurs when one gene does not dominate the other.

l. _____ can cause mutations.

m. _____ is a male gamete.

n. _____ is a female gamete.

o. _____ is the prediction of events happening by chance.

p. _____ is the name for all the genes in a population.

NINE MONTH MIRACLE

PURPOSE: To aid in the understanding of human prenatal growth, to give practice in the construction and interpretation of graphs. The Nine Month Miracle makes an excellent packet on human embryology.

MATERIALS: Human embryonic and fetal drawings, graph, ruler, pen or pencil, string.

PROCEDURE: Measure the given embryo or fetus on each page with a piece of string. Use ruler to convert length of string into inches. If the represented drawing is one-half its actual length, multiply by two to get the correct length. Plot the nine-month growth on the provided graph. Then, answer the following questions:

QUESTIONS:

1. Prenatal growth refers to the growth of a baby before _____ .
2. Nine calendar months equals about _____ days.
3. Between the _____ and _____ months, the fetal growth more than triples.
4. At what month can the sex of a human fetus be determined? _____
5. An infant born at the end of the _____ month has a good chance of survival.
6. The fetus at _____ months measures about ten inches from head to toe.
7. After the _____ month, the embryo assumes human characteristics and is thereafter called a fetus.

At one month the embryo is _____ inches long from head to tail. The head is almost one-third of the length. The tube which will become the heart has been formed and is pulsating. The future arms and legs are buds. This drawing is actual size.

At two months the embryo has a human face and form with arms and legs. Eyes, ears, nose and mouth are developing. It also has a heartbeat and a soft skeleton. The embryo now measures _____ inches from head to buttocks. This drawing is actual size.

The fetus at three months measures _____ inches. At this time sex can be determined. Buds for all the baby teeth are forming. This drawing is actual size.

At the end of the fourth month the fetus has fine hair on the head and body. Its movements may be felt by the mother. It is _____ inches long from head to toe. This drawing is actual size.

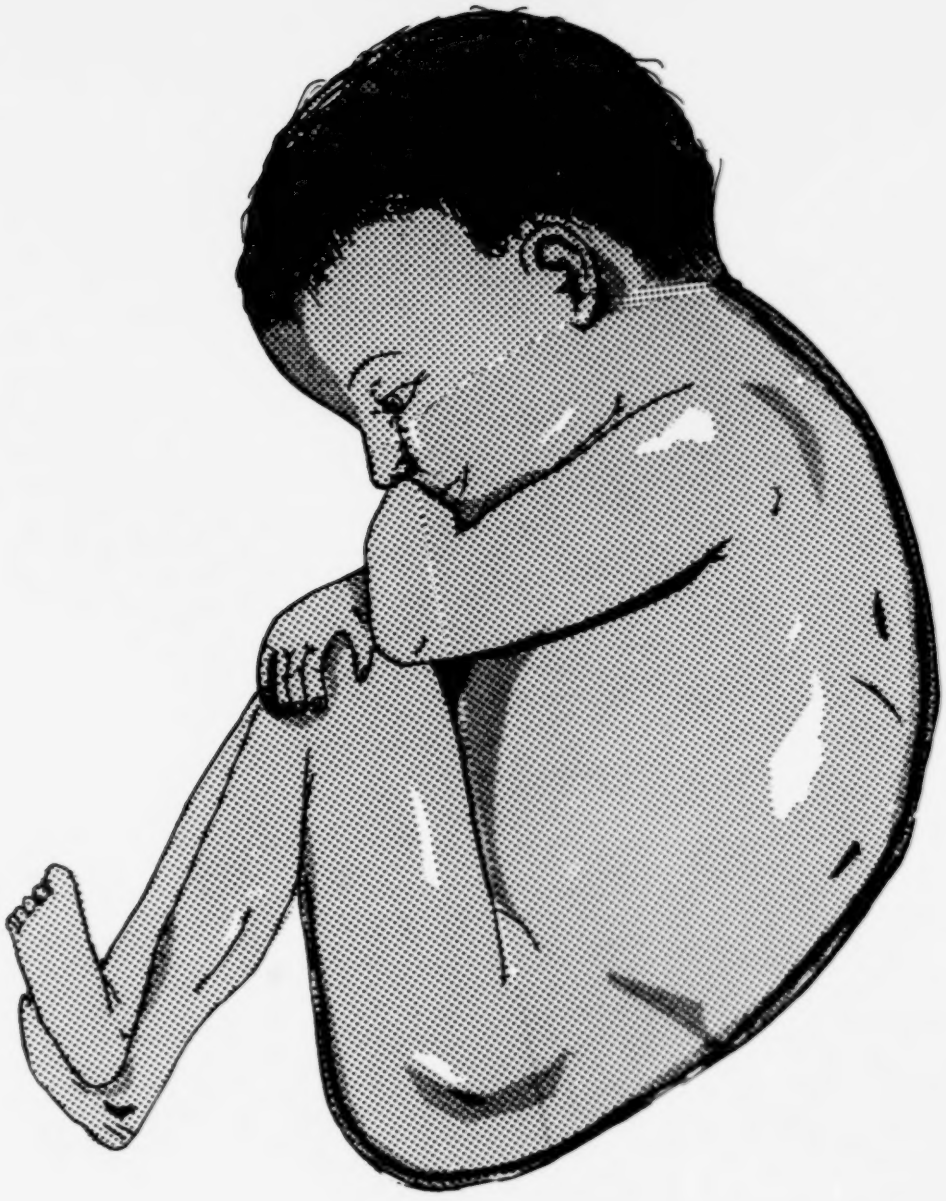
The length of the fetus from head to toe at five months is about _____ inches. Its heartbeat may be heard. There is more movement. This drawing is one-half the actual size.

At six months the fetus weighs about one and one-half pounds and is _____ inches long. It is wrinkled and red with practically no fat under the skin. This drawing is one-half the actual size.

If born at seven months the fetus has some chance of survival. It is _____ inches long and is growing and putting on weight. This drawing is one-half the actual size.

44

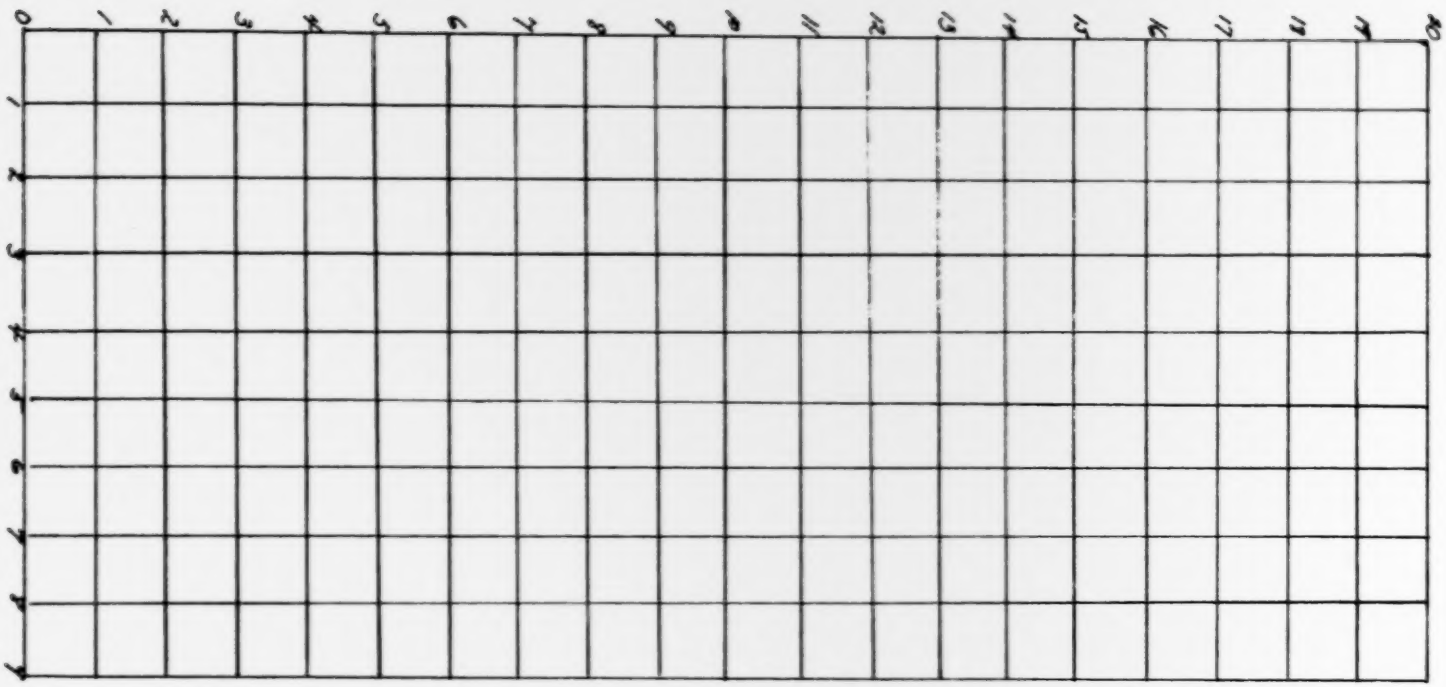
Infants born at the end of eight months have a good chance of survival. The fetus weighs about five pounds and is _____ inches tall. This drawing is one-half the actual size.



At birth the average weight is seven pounds and the infant is approximately _____ in length. It is fully developed. This drawing is one-half the actual size.

NINE MONTH MIRACLE GRAPH

INCHES



MONTHS

FETAL GROWTH

DIRECTIONS: Record each measurement on this graph. Be sure to read all instructions carefully. Each page includes some important information for the completion of this graph.

ANSWER KEY

Page 2: Fact or Fiction

1. Fiction
2. Fiction
3. Fiction
4. Fact
5. Fiction
6. Fact
7. Fiction
8. Fact
9. Fiction
10. Fact

Page 3: Cell Civision

1. e
2. c
3. b
4. d
5. a
6. f

Page 6: Can You Identify a Human Embryo?

a. fish
b. salamander
c. turtle
d. chicken
e. pig
f. rabbit
g. human

Page 7: Tract Your Ancestry

Activity. Answers will vary

Page 9: Boy or Girl?

Answers will vary; if experiment is done several times the ratio will be almost even numbers of boys to girls.

Page 11: Genetic Corn

1. c
2. b
3. a

Page 13: Differences in the Gestation Period of Mammals

Graph

Page 15: Transfusion Stoplights

Green	Green	Green	Green
Red	Green	Green	Red
Green	Red	Green	Red
Red	Red	Green	Red

Page 16: Chromosome Count

The beetle has an extra **Y**, extra **S**, and extra **J**.

Page 18: Baby Mix Up

1. Baby A belongs to the Gonzales
2. Baby B belongs to the Pepronis
3. Baby C belongs to the McBrides

Page 19: Incubation of Chick Eggs

Activity

Page 23: DNA

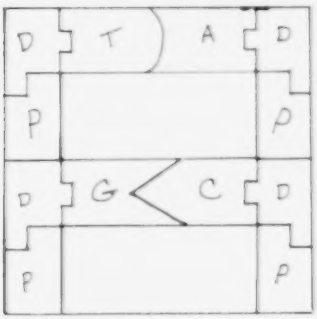
Activity

Page 26: A Chromosome Study

The beetle will lack an antenna (extra Y_4); will be blind (extra S_7); will lack the first pair of legs (extra J_3).

Page 27: Build a DNA Ladder

1. C is joined to G and D.
2. T is joined to A and D.
3. G is joined to C and D.
4. A is joined to T and D.
5. Sugars are joined to phosphates and T, A, C and G.
6. Rungs of the ladder T, A, G, C.
7. Sides of the ladder are D, P.
8. Answers will vary.



Page 30: Genetic Magic Square

13 a	2 b	3 c	16 d
12 e	7 f	6 g	9 h
8 i	11 j	10 k	5 l
1 m	14 n	15 o	4 p

Page 32: Nine Month Miracle Questions

1. birth
2. 270 - 280 days
3. 2nd and 3rd
4. 3rd
5. 8th
6. 5
7. 2nd

Pages 33-40: Nine Month Miracle

Answers will vary according to individual measurements. The following answers are approximate.

1 month	¼ inch head to tail
2 months	1 inch head to buttocks
3 months	over 3 inches
4 months	6½ inches head to toe
5 months	10 inches
6 months	12 inches
7 months	15 inches
8 months	16½ inches
9 months	20 inches

Page 41: Nine Month Miracle Graph

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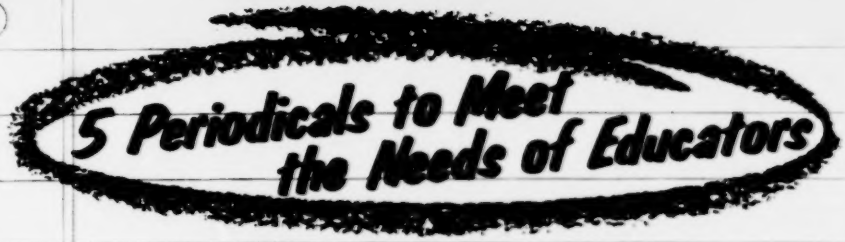

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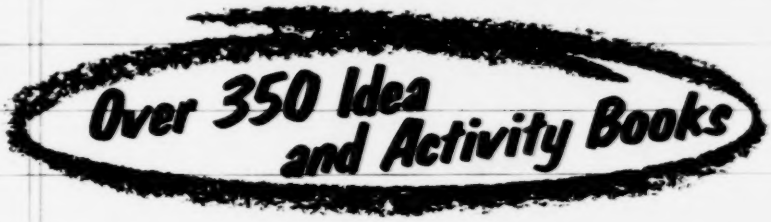

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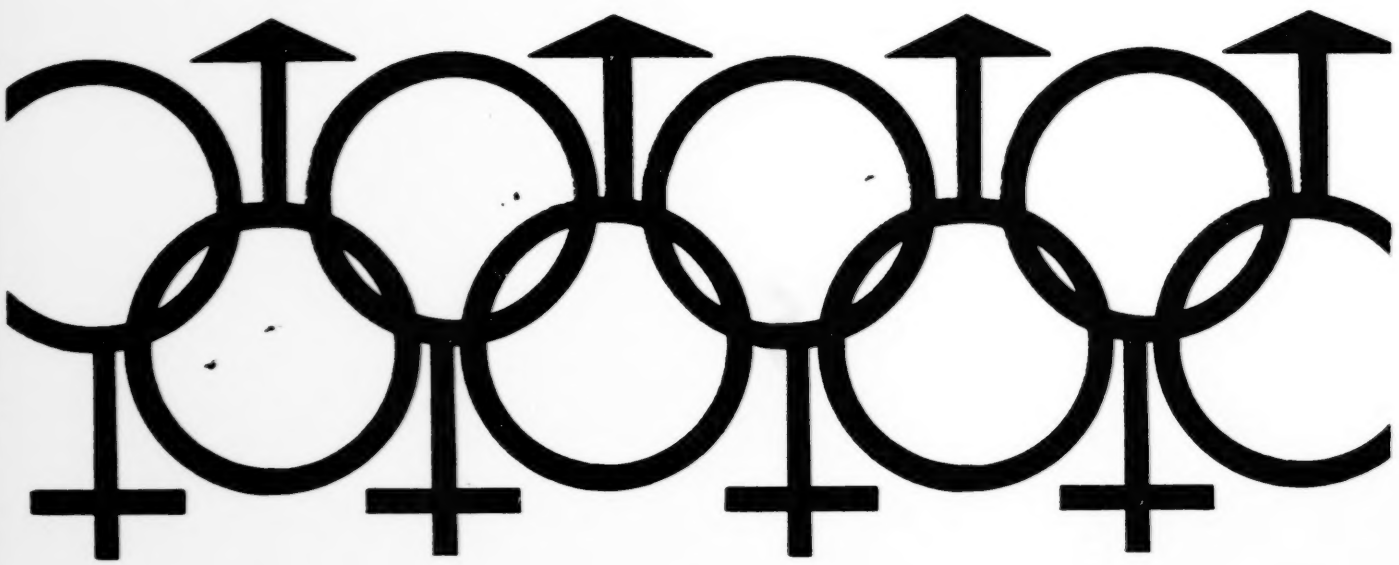

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